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Brief Original Report

High school females and those with other vaccinations most likely to complete the Human Papillomavirus vaccine

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ABSTRACT

Objective. Adolescent females' HPV vaccine completion in the U.S. is low. More recent research is needed to investigate factors that relate to HPV vaccine completion among female adolescents in the United States.**Methods.** Provider-validated data from the 2012 National Immunization Survey-Teen for females ages 13–17 years (N = 9058) were analyzed from February–May 2014 using survey sample weighted statistics. A multivariable Poisson regression estimated prevalence ratios (PR) for factors influencing HPV vaccine completion: mother's education, poverty status, adolescent's grade, facility type, and receipt of other adolescent vaccinations.**Results.** In multivariable models, 9–12th grade daughters were more likely to complete HPV vaccination than 6–8th grade daughters (PR = 1.81, 95% CI = 1.58–2.06). Those seen in hospital facilities completed HPV vaccination 1.3 times more (PR = 1.29, 95% CI = 1.02–1.62) and those seen in private facilities were 1.2 times more likely to complete (PR = 1.22, 95% CI = 1.01–1.48), than those seen in public facilities, respectively. Compared to those without recommended adolescent vaccinations, receipt of seasonal influenza vaccination related to HPV vaccine completion (PR = 1.71, 95% CI = 1.54–1.89), as did receipt of TDAP vaccination (PR = 1.17, 95% CI = 1.03–1.33) and Meningitis vaccination (PR = 2.74, 95% CI = 2.20–3.42).**Conclusions.** Adolescent females in high school, seen in private/hospital facilities, and up to date on other recommended adolescent vaccinations are most likely to complete the HPV vaccine.© 2015 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Background

The Healthy People 2020 HPV vaccination goal among females is 80% (Healthy People, 2020 Topics & Objectives: U.S. Department of Health and Human Services, 2014). In 2012, 33.4% of eligible adolescents have completed HPV vaccination in the United States (U.S.), with variation among states (Mississippi = 12.1% to Rhode Island = 57.7%) (2012 NIS-Teen Vaccination Coverage Table Data: Centers for Disease Control and Prevention, 2014).

In 2010, minority race adolescents were more likely to initiate the HPV vaccine, (Laz et al., 2012) but less likely to complete the series (Niccolai et al., 2011; Reiter et al., 2014). In 2009, older adolescents

were less likely to complete HPV vaccination than younger patients (Hirth et al., 2012). Those living below poverty level are less likely to complete HPV vaccination (Niccolai et al., 2011). Research is needed to provide updated data on factors influencing HPV vaccine completion.

This is one of the first studies of 2012 National Immunization Survey-Teen (NIS-Teen) data to investigate HPV vaccine completion factors among female adolescents in the U.S. Those individuals whose mother had lower education, living below poverty level, of racial or ethnic minority, younger adolescents, and receiving the vaccine at private facilities, or from a Vaccine for Children provider were hypothesized to have lower completion of the HPV vaccine. Individuals with other adolescent vaccinations were expected to be more likely to complete the HPV vaccine than those without other vaccines.

Methods

This secondary data analysis occurred from February–May 2014 and utilized the 2012 NIS-Teen survey, a publicly available, nationally

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representative survey with a complex sampling design described elsewhere (Jain et al., 2009). Annually, the NIS-Teen uses random digit dialing to sample parents and adolescent health care providers through a telephone and mailed survey, respectively. These data assess adolescent vaccination coverage among 13–17 year olds in the U.S. The 2012 NIS-Teen had a cellular-household response rate of 23.6%, and a landline-household response rate of 55.1% (National State Vaccination Coverage Among Adolescents Aged 13–17 Years – United States, 2012, 2014). Analysis of publicly available data is considered exempt research by the University of Utah Institutional Review Board.

The Andersen healthcare utilization model guided the selection of factors examined in this study. Health services use is determined by three components: predisposing factors, enabling factors, and need. Predisposing factors include patient and caregiver/parent demographics (e.g., age, education, marital status, race, and income). Enabling factors include access to insurance, provider access to vaccinations, and access to other adolescent immunizations. Need includes perceived need for healthcare services which may relate to parent prioritization of other recommended adolescent vaccinations (Anderson, 1995).

Table 1

Bivariate analysis of female respondent characteristics: full sample and those with HPV completion^{a,b}. Bold indicates statistically significant p-values that are less than p=0.05.

	Total (N = 9058)	% ^c (95% CI)	HPV completion ^d (N = 3246)	% ^c (95% CI)	p-Value ^e
Age (mother)					0.738
≤34 years	671	10.0 (8.8, 11.4)	217	10.4 (8.1, 13.2)	
35–44 years	3709	45.3 (43.5, 47.2)	1304	44.2 (41.1, 47.4)	
≥45 years	4678	44.6 (42.8, 46.5)	1725	45.4 (42.3, 48.5)	
Education (mother)					0.007
<12 years	905	14.3 (12.8, 15.9)	352	16.7 (14.0, 19.7)	
12 years	1723	24.0 (22.4, 25.8)	615	23.7 (21.1, 26.5)	
>12 years (some college)	2547	27.8 (26.1, 29.5)	836	24.1 (21.6, 26.8)	
College graduate	3883	33.9 (32.3, 35.6)	1443	35.5 (32.7, 38.5)	
Poverty status					0.048
Above poverty (>\$75 k)	3943	33.4 (31.8, 35.1)	1472	34.4 (31.6, 37.3)	
Above poverty (≤\$75 k)	3335	39.2 (37.3, 41.0)	1101	35.9 (32.9, 39.1)	
Below poverty	1515	27.4 (25.6, 29.4)	587	29.7 (26.5, 33.0)	
Missing, n (%)	265 (2.93)		86 (2.65)		
Marital status (mother)					0.944
Married	6691	64.0 (62.1, 65.9)	2354	64.1 (60.9, 67.1)	
Other	2367	36.0 (34.1, 37.9)	892	35.9 (32.9, 39.1)	
Adolescent's race/ethnicity					0.262
Hispanic	1231	21.8 (20.1, 23.7)	455	23.2 (20.2, 26.5)	
Non-Hispanic White only	6058	54.2 (52.4, 56.1)	2151	54.7 (51.5, 57.8)	
Non-Hispanic Black only	899	14.2 (12.9, 15.7)	306	12.3 (10.4, 14.6)	
Other	870	9.7 (8.6, 11.0)	334	9.8 (8.0, 11.9)	
Adolescent's current grade					<0.001
6th to 8th grade	2511	27.1 (25.5, 28.7)	590	18.0 (15.8, 20.5)	
9th to 12th grade	6441	71.5 (69.8, 73.1)	2615	80.9 (78.5, 83.2)	
HS graduate/GED	106	1.4 (1.0, 2.1)	41	1.0 (0.6, 1.7)	
Adolescent's health insurance					0.475
Employment/union	5928	56.6 (54.7, 58.5)	2102	55.6 (52.4, 58.8)	
Other	3054	43.4 (41.5, 45.3)	1118	44.4 (41.2, 47.6)	
Missing, n (%)	76 (0.84)		26 (0.80)		
Facility type for adolescent's providers					<0.001
All public facilities	1270	15.5 (14.1, 17.0)	367	12.1 (10.0, 14.5)	
All hospital facilities	793	7.4 (6.5, 8.3)	337	8.1 (6.6, 9.8)	
All private facilities	4213	50.8 (49.0, 52.7)	1567	55.4 (52.2, 58.6)	
Mixed/other	2427	26.3 (24.7, 28.0)	861	24.5 (21.9, 27.3)	
Missing, n (%)	355 (3.92)		114 (3.51)		
Do adolescent's providers order vaccinations from state/local health department					0.052
All providers	5988	64.5 (62.6, 66.3)	2232	67.3 (64.2, 70.2)	
Some but possibly not all	1309	14.0 (12.8, 15.4)	466	13.9 (11.8, 16.4)	
No providers	1008	11.7 (10.6, 12.9)	316	11.0 (9.3, 12.9)	
Don't know	728	9.8 (8.6, 11.2)	232	7.9 (6.3, 9.7)	
Missing, n (%)	25 (0.28)				
Influenza vaccination ^f					<0.001
Yes	3850	38.9 (37.2, 40.7)	1887	56.0 (52.8, 59.1)	
No	5208	61.1 (59.3, 62.8)	1359	44.0 (40.9, 47.2)	
TDAP vaccination ^g					<0.001
Yes	6085	65.0 (63.2, 66.8)	2465	72.4 (69.2, 75.4)	
No	2973	35.0 (33.2, 36.9)	781	27.6 (24.7, 30.7)	
Meningitis vaccination ^h					<0.001
Yes	6657	73.5 (71.7, 75.1)	2916	90.7 (88.5, 92.4)	
No	2401	26.5 (24.9, 28.3)	330	9.3 (7.6, 11.5)	

^a Respondents from the Virgin Islands were excluded.

^b Female adolescents in the U.S. with adequately complete provider-reported immunization records in the 2012 NIS-Teen survey were included in the analysis.

^c Weighted percentages from Dual-Frame Sampling Weights.

^d HPV completion includes those who had received at least 3 doses of the HPV vaccine.

^e Survey weighted Pearson chi-square test compared those with HPV vaccine completion to those who did not receive 3 doses.

^f Adolescent has taken at least one dose of seasonal influenza vaccination in the past three years.

^g Adolescent has taken at least one dose of TDAP only vaccination since age 10 years old and before 13 years old.

^h Adolescent has taken at least one dose of Meningitis vaccination.

Participants

Parents consented to have their adolescent's provider contacted to verify vaccine receipt ([About the National Immunization Survey: Centers for Disease Control and Prevention, 2014](#)). Female adolescents with provider-verified immunization records were included in the analysis (N = 9058).

Outcome measures

The outcome of interest was completion of the 3-dose HPV vaccine series. After phone interviews were conducted with parents or guardians, providers were mailed a questionnaire to acquire provider-confirmed immunization information for receipt of 3 doses of the vaccine ([Centers for Disease Control and Prevention. National, Regional, State, and Selected Local Area Vaccination Coverage Among Adolescents Aged 13–17 Years – United States, 2013](#)). Participants with provider verified receipt of three doses were considered to have completed the vaccine. Variable weights selected adjust for respondents with missing provider data.

Statistical analysis

Provider-phase sampling weight for both landline and cell-phone samples in the U.S. proper was used to produce Dual-Frame point estimates and 95% confidence intervals (CI). Missing values of each variable were excluded. Frequency counts, percents, and 95% CI, each properly weighted by survey sampling weights, were reported for the total sample and HPV vaccine completion subgroup. For categorical variables, a survey weighted Pearson chi-square test was used to compare distributions between those with HPV vaccine completion to those with less than 3 doses. A survey weighted multivariable Poisson regression was fitted to assess the impact of selected predictors and reported as an adjusted prevalence ratio (PR) with 95% CI. All tests were two-sided comparisons in STATA version 13.1 (College Station, Texas).

Results

There were 9058 respondents with provider-verified vaccination records and daughters ages 13–17 years. Of these, 3246 had completed the HPV vaccine series. In [Table 1](#), mothers were mostly aged ≥ 35 , college graduates, and married. Adolescents were primarily living above poverty level, Non-Hispanic White, 9th–12th grade, and on private health insurance. In bivariate analyses of female adolescent characteristics, comparing those who had completed the HPV vaccine to those who had not, demographic factors related to HPV vaccine completion included: mother's education, poverty status, and adolescent's current grade, all $p < 0.05$. Healthcare factors associated with HPV vaccine completion included facility type for adolescent's providers and completion of other recommended adolescent vaccinations (i.e., influenza, TDAP, Meningitis), all $p < 0.05$.

Multivariable analysis of factors predicting HPV vaccine completion among female adolescents

In [Table 2](#), respondents whose mothers had some college, but no college degree, were less likely to complete the HPV vaccine than those whose mothers had less than 12 years of education (PR = 0.81, 95% CI = 0.67–0.99, $p = 0.036$). Daughters in 9–12th grade were 1.8 times more likely to have completed HPV vaccination than those in 6–8th grade (PR = 1.81, 95% CI = 1.58–2.07, $p < 0.001$). Female adolescents who were seen in hospital facilities were 1.3 times more likely to complete (PR = 1.28, 95% CI = 1.01–1.61, $p = 0.037$) and those seen in private facilities were 1.2 times more likely to complete (PR = 1.21, 95% CI = 1.00–1.45, $p = 0.050$), compared to those seen in public facilities.

Table 2

Multivariable analysis of factors predicting HPV vaccine completion among female adolescents, NIS-Teen 2012^a.

	Adjusted vaccination coverage ^b (95% CI)	Prevalence ratio ^c (95% CI)
Age (mother)		
≤34 years	37.8 (30.0, 45.6)	Reference
35–44 years	33.4 (30.7, 36.1)	0.88 (0.71, 1.10)
≥45 years	32.9 (30.4, 35.3)	0.87 (0.70, 1.09)
Education (mother)		
<12 years	38.0 (32.0, 44.1)	Reference
12 years	34.3 (30.4, 38.1)	0.90 (0.75, 1.09)
>12 years (some college)	30.9 (27.7, 34.0)	0.81 (0.67, 0.99)
College graduate	33.4 (30.3, 36.6)	0.88 (0.72, 1.07)
Poverty status		
Above poverty (>\$75 k)	32.9 (29.6, 36.1)	Reference
Above poverty (≤\$75 k)	32.9 (30.1, 35.7)	1.00 (0.88, 1.13)
Below poverty	35.4 (31.0, 39.9)	1.08 (0.90, 1.29)
Marital status (mother)		
Married	32.9 (30.6, 35.2)	Reference
Other	34.8 (31.4, 38.2)	1.06 (0.93, 1.20)
Adolescent's race/ethnicity		
Hispanic	33.0 (28.4, 37.6)	Reference
Non-Hispanic White only	35.8 (33.4, 38.1)	1.08 (0.93, 1.27)
Non-Hispanic Black only	28.1 (23.4, 32.8)	0.85 (0.69, 1.06)
Other	31.8 (26.7, 36.8)	0.96 (0.78, 1.19)
Adolescent's current grade		
6th to 8th grade	21.3 (18.7, 24.0)	Reference
9th to 12th grade	38.6 (36.3, 40.8)	1.81 (1.58, 2.07)
HS graduate/GED	32.7 (15.6, 49.8)	1.53 (0.90, 2.62)
Adolescent's health insurance		
Employment/union	32.8 (30.2, 35.4)	Reference
Other	34.6 (31.6, 37.7)	1.06 (0.93, 1.20)
Facility type for adolescent's providers		
All public facilities	28.8 (23.9, 33.7)	Reference
All hospital facilities	36.8 (31.0, 42.6)	1.28 (1.01, 1.61)
All private facilities	34.7 (32.1, 37.4)	1.21 (1.00, 1.45)
Other	32.9 (29.2, 36.5)	1.14 (0.93, 1.40)
Do adolescent's providers order vaccinations from state/local health department		
All providers	34.6 (32.5, 36.8)	Reference
Some but possibly not all	29.9 (24.9, 34.9)	0.86 (0.72, 1.04)
No providers	35.0 (30.1, 40.0)	1.01 (0.87, 1.18)
Don't know	28.6 (22.5, 34.6)	0.82 (0.66, 1.03)
Influenza vaccination ^d		
Yes	44.1 (41.3, 46.9)	1.71 (1.54, 1.90)
No	25.8 (23.6, 28.1)	Reference
TDAP vaccination ^e		
Yes	35.3 (33.1, 37.4)	1.18 (1.04, 1.35)
No	29.8 (26.4, 33.3)	Reference
Meningitis vaccination ^f		
Yes	39.1 (36.9, 41.3)	2.75 (2.20, 3.42)
No	14.2 (11.2, 17.2)	Reference

^a Respondents from the Virgin Islands were excluded as were those with missing values (N = 8388). Female adolescents in the U.S. with adequately complete provider-reported immunization records in the 2012 NIS-Teen survey were included in the analysis.

^b Multivariable Poisson regression.

^c Predictive marginal prevalence.

^d Adolescent has taken at least one dose of seasonal influenza vaccination in the past three years.

^e Adolescent has taken at least one dose of TDAP only vaccination since age 10 years old and before 13 years old.

^f Adolescent has taken at least one dose of Meningitis vaccination.

Similar to the bivariate analyses, receipt of other adolescent vaccinations increased the likelihood of HPV vaccine completion. Those with at least one dose of seasonal influenza vaccination in the past three years were 1.7 times more likely to complete HPV vaccination (PR = 1.71, 95% CI = 1.54–1.90, $p < 0.001$) than those without influenza vaccination. Adolescents with at least one dose of TDAP vaccination ages 10–13 years were 1.2 times more likely to complete HPV vaccination (PR = 1.18, 95% CI = 1.04–1.35, $p = 0.012$) than those who had not received TDAP. Adolescents with at least one Meningitis vaccination were 2.7 times more likely to complete HPV vaccination than those without a Meningitis vaccination (PR = 2.75, 95% CI = 2.20–3.42, $p < 0.001$).

In sensitivity analyses, a multivariable model was used to investigate factors related to females who received three doses of the HPV vaccine among those who had a minimum of 24 weeks between the receipt of the first dose of the HPV vaccine and the date of the interview ($n = 4548$). Females in higher grades were more likely to complete the 3-dose HPV vaccine series than females in 6th–8th grades ($p < .001$). Females attending private facilities compared to public facilities ($p < .01$), and females with the flu and TDAP vaccines (both $p < .05$) were also more likely to complete the 3-dose series within the recommended time frame (data not shown).

Discussion

Prevalence of HPV types 6, 11, 16 and 18 have declined over 50% following HPV vaccine introduction among girls ages 14–19 in the U.S., yet national immunization rates are far below the Healthy People 2020 goal of 80% completion among adolescent females (Healthy People, 2020 Topics & Objectives: U.S. Department of Health and Human Services, 2014; Accelerating HPV Vaccine Uptake: Urgency for Action to Prevent Cancer. A Report to the President of the United States from the President's Cancer Panel. Bethesda MD: National Cancer Institute, 2014). To our knowledge, this is the first study to examine factors related to HPV vaccine completion using the 2012 NIS-Teen survey.

The ACIP has recommended that females ages 11–12 are to receive three doses of the HPV vaccine since 2006 (Centers for Disease Control and Prevention (CDC). MMWR 2007). These results indicate that adolescent females are not receiving the HPV vaccine at recommended ages. Despite parental concerns about vaccine safety and efficacy, (Markowitz et al., 2007; Oldach and Katz, 2012) clinical trial data and safety monitoring by the CDC, FDA and vaccine manufacturers indicate that the vaccine is highly safe and risk for serious reaction to the HPV vaccine is extremely rare (Centers for Disease Control and Prevention. National, Regional, State, and Selected Local Area Vaccination Coverage Among Adolescents Aged 13–17 Years – United States, 2013; Kepka et al., 2014; Gee et al., 2011; Chao et al., 2012; Klein et al., 2012). HPV vaccine administration is optimal during this age, when adolescents have the best immune response to the vaccination (Accelerating HPV Vaccine Uptake: Urgency for Action to Prevent Cancer. A Report to the President of the United States from the President's Cancer Panel.). Providers and parents need to recognize the full-panel of recommended adolescent vaccinations and improve primary care by adhering to recommended vaccine schedules.

Future studies are needed to investigate the importance of pairing HPV vaccination with other recommended adolescent immunizations, encouraging providers to make strong recommendations for the receipt of HPV vaccination, and clinic-based parent and patient reminder systems for 3-dose series completion.

Limitations

This study is limited by non-response among the NIS-Teen sample, with adequate provider-verified vaccination data available among only 56.4% of cellular and 62% of landline respondents. After weighting adjustments, bias may persist (National State Vaccination Coverage Among Adolescents Aged 13–17 Years – United States, 2012, 2014). Lastly, only one multivariable regression model was included in our analyses.

Conclusions

Future development of multifaceted, comprehensive strategies to improve clinical recommendation and administration of the HPV vaccine series is needed, including: strong and consistent provider recommendations, use of electronic health records and information

systems to incorporate reminder systems for adolescents who are due for HPV vaccination, and policies that ensure adequate provider reimbursement for administration of the HPV vaccine series (Accelerating HPV Vaccine Uptake: Urgency for Action to Prevent Cancer. A Report to the President of the United States from the President's Cancer Panel). Moreover, community outreach and education promoting HPV vaccination as a cancer prevention method, and addressing adolescents' and caregivers' concerns about vaccine safety and efficacy, may also improve the uptake of the HPV vaccine.

Conflict of interest/financial disclosure statement

No conflicts of interest or financial disclosures were reported by the authors of this paper.

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